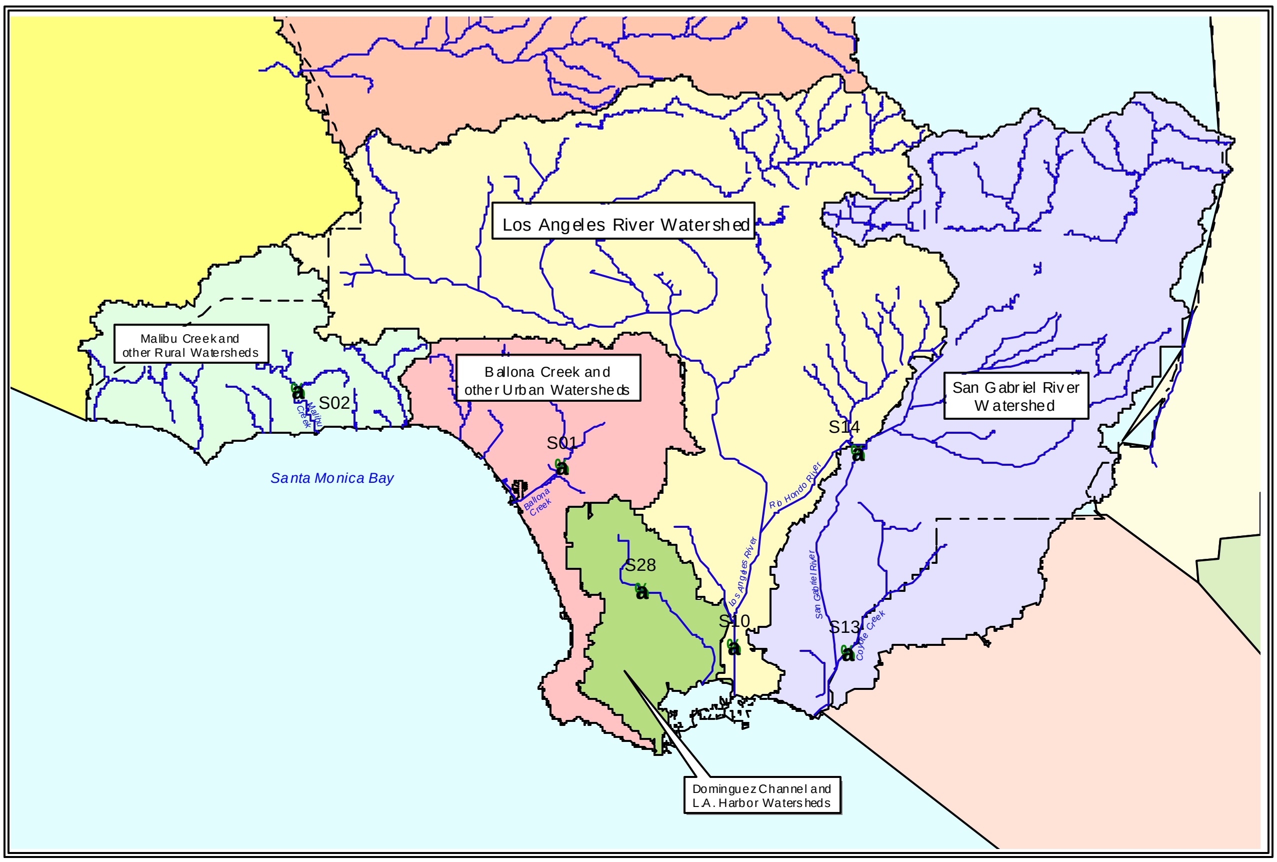
LOS ANGELES COUNTY 2001-2002 STORM WATER QUALITY MONITORING REPORT



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AB411	Assembly Bill 411
ACOE	Army Corps of Engineers
ACWM	Department of Agricultural Commissioner/Weights and Measures
BMPs	Best Management Practices
BOD_5	Biochemical Oxygen Demand (five day)
COD	Chemical Oxygen Demand
CTR	California Toxics Rule
2,4-D	2,4-dichlorophenoxy
GIS	Geographical Information Systems
IC25	25% Inhibitory Concentration
IC50	50% Inhibitory Concentration
ID	Identification
LACDPW	Los Angeles County Department of Public Works
LC25	25% Lethal Concentration
LC50	50% Lethal Concentration
MBAS	Methylene Blue Active Substances
MDL	Method Detection Limit
mg/l	milligrams per liter
µg/l	micrograms per liter
ML	Minimum Level
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
NOEC	No Observed Effects Concentration
NPDES	National Pollutant Discharge Elimination System
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
pH	negative logarithm of hydrogen ion concentration
QA/QC	Quality Assurance/Quality Control
R^2	coefficient of determination
SQMP	Stormwater Quality Management Program
SVOC	Semi-Volatile Organic Compounds
TIE	Toxicity Identification Evaluation
TKN	Total Kjeldahl Nitrogen

TMDL	Total Maximum Daily Load
2,4,5-TP	2-(2,4,5-trichorophenoxy) propanoic acid
TPH	Total Petroleum Hydrocarbons
TRE	Toxicity Reduction Evaluation
TSS	Total Suspended Solids
TU	Toxicity Units
USEPA	United States Environmental Protection Agency

MONITORING PROGRAM OBJECTIVES

The major objectives of the Monitoring Program outlined in the Municipal Storm Water Permit are to:

- Assess compliance with the Los Angeles County Municipal Storm Water Permit No. CAS004001;
- Measure and improve the effectiveness of the Stormwater Quality Management Plans (SQMPs);
- Assess the chemical, physical, and biological impacts of receiving waters resulting from urban runoff;
- Characterize storm water discharges;
- Identify sources of pollutants; and
- Assess the overall health and evaluate long-term trends in receiving water quality.

The Monitoring Program was designed to address the above objectives through the implementation of five core monitoring elements (mass emission monitoring, water column toxicity monitoring, tributary monitoring, shoreline monitoring, and trash monitoring), two regional monitoring elements (estuary sampling and bioassessment), and three special studies (the new development impacts study in the Santa Clara Watershed, the peak discharge impact study, and the Best Management Practice (BMP) effectiveness study). Due to varying compliance dates for each element, only mass emission, water column toxicity, and shoreline monitoring, under the core monitoring program, were performed during the 2001-2002 monitoring period.

SUMMARY OF MONITORING RESULTS

Mass Emission Monitoring

The purpose of mass emission monitoring is to estimate the mass emissions from the Municipal Separate Storm Sewer System (MS4), assess trends in the mass emissions over time, and determine if the MS4 is contributing to exceedances of water quality standards by comparing results to applicable standards in the Basin Plan, the Ocean Plan, or the California Toxics Rule (CTR), and with emissions from other discharges.

Flows were measured and water quality samples were taken at the following six mass emission monitoring sites: Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, and Dominguez Channel. At least three storm events were sampled at each mass emission station, except for at the Dominguez Channel monitoring station, where samples were only taken during two storm events (totaling two grab samples and one composite sample). Sampling at Dominguez Channel was required to begin by February 1, 2002, however, since this station was newly added to the mass emission monitoring program under the 2001 Municipal Storm Water Permit and due to a lack of storm events between February 1, 2002 and the end of the storm season (April 15, 2002), it was not possible to collect three composite and grab samples from the

Dominguez Channel mass emission station during wet weather, as required by the Municipal Storm Water Permit.

Based on results of the mass emission monitoring, three different water quality analyses, i.e., a comparison to appropriate water quality standards, an analysis of pollutant loadings and trends, and an evaluation of the correlation between metals/polycyclic aromatic hydrocarbons (PAHs) and total suspended solids (TSSs), were conducted.

Summaries of the analyses are as follows:

Comparison Study

A comparison of the monitoring results to the applicable water quality standards in the Basin Plan, the Ocean Plan, or the CTR was conducted. The objectives in the AB411 were used to provide standards for bacteria.

The following conclusions were drawn from the comparison study:

- The monitoring program has identified the nearly ubiquitous existence of bacteria in wet weather for all six of the mass emission monitoring stations. Densities of total coliform, fecal coliform, and enterococcus exceeded the public health criteria of AB411 for each storm at each monitoring station, with the exception of Malibu Creek, which only exceeded the total and fecal coliform objectives half of the time. The Malibu Creek station also shows consistently lower indicator bacteria counts than other mass emission stations.
- For all monitoring stations, there was no clear trend between bacteria densities and storm events.
- For all monitoring stations, over 66% of the ammonia samples exceeded the Basin Plan water quality objectives.
- For all monitoring stations, 50-100% of the total copper samples exceeded the Ocean Plan water quality objective.
- At least 40% of the dissolved copper samples taken at the Ballona Creek, Los Angeles River, Coyote Creek, and Dominguez Channel monitoring stations exceeded the CTR water quality objective.
- 50% of the dissolved selenium samples collected at the Malibu Creek monitoring station exceeded the CTR water quality objective. This is the only monitoring station that showed exceedances.
- 40% of the dissolved lead samples collected at the Los Angeles River monitoring station and 17% of the samples collected at the San Gabriel River monitoring station exceeded the CTR water quality objective. No other monitoring stations showed exceedances.

Loading and Trend Analysis

An estimation was made of the total pollutant loads due to storm water and urban runoff for each mass emission station. An analysis of trends in storm water or receiving water quality was also conducted.

The following conclusions were deduced from the loading analysis:

- The storm on November 24, 2001 at the Ballona Creek and Los Angeles River monitoring stations produced loadings of 2,001 tons and 12,145 tons, respectively. The storm on this date produced the highest amount of precipitation at both of these stations during the 2001-2002 monitoring season. Besides these two occurrences, the mass emission loadings for TSSs were less than 1,300 tons for all monitoring stations for all storms.
- The Los Angeles River is the largest contributor of TSSs out of the six mass emission stations monitored.
- Loading was highest for most constituents at each monitoring station during the November 24, 2001 storm.
- Metal loading was the greatest for the Los Angeles River.

The following conclusions were drawn from the trend analysis:

- The high levels of zinc found at monitoring stations between 1994-2000 were not present in the samples taken during the 2001-2002 storm season.
- The rainfall was approximately 11.3 inches below average during the 2001-2002 storm season.

Correlation Study

An analysis of the correlation between metals/PAHs and TSS levels was performed. The study focused on metals because there were not enough PAH samples to find any correlation.

A trend line was placed on each of the metals-versus-TSS plots and the coefficient of determination (R^2) was measured to see if there was any correlation between each metal and TSSs for all of the mass emission monitoring stations except for Dominguez Channel. The correlation study could not be conducted for the Dominguez Channel monitoring station since there were not a sufficient number of sampling events for any statistical analysis. The closer R^2 is to the value 1, the stronger the correlation.

The following conclusions were deduced from the correlation study analysis:

- All of the five mass emission monitoring sites showed a positive correlation between total manganese and TSSs. Each site had an R^2 value greater than 0.865, except for San Gabriel River, which had an R^2 value of 0.586.
- Ballona Creek, Malibu Creek, Los Angeles River, and Coyote Creek showed a strong positive correlation between total aluminum and TSSs, having R^2 values of 0.9271, 0.9326, 0.7953, and 0.7699, respectively.
- Three of the mass emission sites, Ballona Creek, Coyote Creek, and San Gabriel River, showed a slightly positive correlation between dissolved nickel and TSSs, with R^2 values ranging from 0.615 to 0.67.

Water Column Toxicity Monitoring

The purposes of water column toxicity monitoring are to evaluate the extent and causes of toxicity in receiving waters and to modify and utilize the SQMP to implement practices that eliminate or reduce sources of toxicity in storm water.

Composite samples were taken at the mass emission monitoring stations. On March 19, 2002, wet weather samples were collected from the Los Angeles River, Coyote Creek, San Gabriel River, and Dominguez Channel mass emission stations. No samples were collected from the Ballona Creek or Malibu Creek mass emission stations due to insufficient runoff.

A minimum of one freshwater and one marine species was used for toxicity testing, specifically Ceriodaphnia dubia (water flea) 7-day survival/reproduction and Strongylocentrotus purpuratus (sea urchin) fertilization.

Results calculated from the Ceriodaphnia dubia and sea urchin tests included the no observed effect concentration (NOEC), 50% lethal concentration (LC50), 50% inhibitory concentration (IC50), and toxicity unit (TU). NOEC is the highest concentration causing no effect on the test organisms. LC50 is the concentration that produces a 50% reduction in survival. IC50 is the concentration causing 50% inhibition in growth or reproduction. TU is defined in the permit as 100/(LC50 or IC50). A TU value greater than or equal to one is considered substantially toxic and requires a toxicity identification evaluation (TIE).

The following conclusions were deduced from water column toxicity testing:

- Ceriodaphnia dubia survival was not significantly affected by exposure to any of the samples. Each undiluted sample caused less than a 50% reduction in survival. This resulted in each sample being less than one toxic unit, meaning none of the samples were substantially toxic.
- The samples tested for Ceriodaphnia dubia reproduction from the Los Angeles River had an LC50 value equal to 92.36%. This means the Los Angeles River sample caused a 50% decrease in reproduction when it was diluted to 92.36% of its original strength. This represents a TU of 1.08. A TIE was not completed because there was not sufficient runoff to collect the required sample volume for such an analysis. The samples taken from the other three stations had TU values less than one.
- In the sea urchin fertilization tests, the Los Angeles River, San Gabriel River, and Dominguez Channel had IC50 values of 52.20%, 55.30%, and 52.63% which equates to TU values of 1.92, 1.81, and 1.90, respectively. Again, a TIE was not completed because there was not sufficient runoff to collect the required sample volume for such an analysis. The sample from Coyote Creek was not substantially toxic to sea urchin fertilization.

Shoreline Monitoring

The City of Los Angeles is required to monitor shoreline stations to evaluate the impacts to coastal receiving waters and the loss of recreational beneficial uses resulting from storm water/urban runoff. Also, the Municipal Storm Water Permit required the City of Los Angeles to annually assess shoreline water quality data and submit it to the Principal Permittee for inclusion in the monitoring report. Therefore, the City of Los Angeles' assessment is included in Appendix C of this monitoring report.

Recommendations

As stated previously, there was not a sufficient number of storm events and, for some of the storm events, there was not enough runoff for collecting the sample volume needed for further analysis during the 2001-2002 storm season; therefore, it was not possible to complete the number of sampling events required for mass emission monitoring at Dominguez Channel and for toxicity monitoring. Make-up samples will be collected during the following storm season and the results will be included in the 2002-2003 monitoring report. Dry weather sampling for both mass emission and toxicity monitoring will be conducted in the near future and the results will also be included in the 2002-2003 monitoring report.

In order to identify and better understand the source(s) of pollution, mass emission monitoring and toxicity monitoring will be continued and additional monitoring, such as tributary monitoring, will be performed in the future as required by the Municipal Storm Water Permit. The effectiveness of the existing control measures used to control pollution will be evaluated by the BMP effectiveness study.

1.1 MONITORING PROGRAM OBJECTIVES

The major objectives of the Monitoring Program outlined in the Municipal Storm Water Permit are to:

- Assess compliance with the Los Angeles County Municipal Storm Water Permit No. CAS004001;
- Measure and improve the effectiveness of the Stormwater Quality Management Plans (SQMPs);
- Assess the chemical, physical, and biological impacts of receiving waters resulting from urban runoff;
- Characterize storm water discharges;
- Identify sources of pollutants; and
- Assess the overall health and evaluate long-term trends in receiving water quality.

The Monitoring Program, developed to address these objectives, has several elements: core monitoring, which includes mass emission station monitoring, water column toxicity monitoring, tributary monitoring, shoreline monitoring, and trash monitoring; regional monitoring, which includes estuary sampling and bioassessment; and three special studies, which include the new development impacts study in the Santa Clara Watershed, the peak discharge impact study, and the Best Management Practice (BMP) effectiveness study.

1.2 MONITORING PROGRAM STATUS

The 1994-95 storm season was the first for which storm water monitoring was required under the 1990 Los Angeles County NPDES Municipal Storm Water Permit No. CA0061654. During the 1994-95 and 1995-96 seasons, automated and manual sampling was conducted to characterize storm water quality and quantity in accordance with the 1990 Municipal Storm Water Permit.

The 1996-97 season was the first storm season in which storm water monitoring was conducted under the 1996 Municipal Storm Water Permit (No. CAS614001). Under the 1996 Municipal Storm Water Permit, the scope of the Monitoring Program was expanded to incorporate further data collection through the Mass Emission, Land Use, and Critical Source Monitoring Programs, and new pilot studies, such as “Wide Channel” and “Low Flow” analyses.

Under the 2001 Municipal Storm Water Permit (No. CAS004001) adopted on December 13, 2001, the Monitoring Program eliminated Land Use and Critical Source elements and focused on core monitoring, regional monitoring, and three special studies. Due to varying compliance dates for each element, only mass emission, water column toxicity, and shoreline monitoring under the core monitoring program are addressed in this Monitoring Report.

1.2.1 Mass Emission Monitoring Program

The objectives of mass emission monitoring are to estimate the mass emissions from the Municipal Separate Storm Sewer System (MS4), assess trends in the mass emissions over time, and determine if the MS4 is contributing to exceedances of water quality standards by comparing results to applicable standards in the Basin Plan, the Ocean Plan, or the California Toxics Rule (CTR), and with emissions from other discharges.

Six mass emission monitoring sites, Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, and Dominguez Channel, were utilized to achieve the objectives outlined above during the 2001-2002 reporting period. Mass emission stations capture runoff from major Los Angeles County watersheds that generally have heterogeneous land use. These stations monitor flow and have automated samplers to collect composite samples during sampling events. Grab samples are also taken at these stations. At least three storm events were sampled at each mass emission site, except for at the Dominguez Channel monitoring station, where samples were only taken during two storm events (totaling two grab samples and one composite sample). Sampling at Dominguez Channel was required to begin by February 1, 2002, however, since this station was newly added to the mass emission monitoring program under the 2001 Municipal Storm Water Permit and due to a lack of storm events between February 1, 2002 and the end of the storm season (April 15, 2002), it was not possible to collect three composite and grab samples from the Dominguez Channel mass emission station, as required by the Municipal Storm Water Permit.

1.2.2 Water Column Toxicity Monitoring Program

The objectives of water column toxicity monitoring are to evaluate the extent and causes of toxicity in receiving waters and to modify and utilize the SQMP to implement practices that eliminate or reduce sources of toxicity in storm water.

Composite samples were taken at the mass emission monitoring stations. On March 19, 2002, wet weather samples were collected from the Los Angeles River, Coyote Creek, San Gabriel River, and Dominguez Channel mass emission stations. No samples were collected from the Ballona Creek or Malibu Creek mass emission stations due to insufficient runoff.

1.2.3 Shoreline Monitoring Program

The City of Los Angeles is required to monitor shoreline stations to evaluate the impacts to coastal receiving waters and the loss of recreational beneficial uses resulting from storm water/urban runoff. Also, the Municipal Storm Water Permit required the City of Los Angeles to annually assess shoreline water quality data and submit it to the Principal Permittee for inclusion in the monitoring report. Therefore, the City of Los Angeles' assessment is included in Appendix C of this monitoring report.

To characterize the runoff quality in Los Angeles County, mass emission sites have been selected for monitoring.

2.1 MASS EMISSION SITE SELECTION

The Los Angeles County Department of Public Works (LACDPW) monitored at six mass emission stations, Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, and Dominguez Channel. Four of the mass emission monitoring stations installed under the original 1990 Permit were retained under the 1996 and the 2001 Municipal Storm Water Permit; specifically Ballona Creek, Malibu Creek, Los Angeles River, and San Gabriel River. The Coyote Creek monitoring station was monitored under the 1990, 1996, and 2001 Municipal Storm Water Permit, though monitoring was not required under the 1996 Municipal Storm Water Permit. The Dominguez Channel mass emission station was also monitored during the 2001-2002 season. The six mass emission monitoring stations were used to collect water quality data from over 1648 square miles.

2.2 MASS EMISSION MONITORING LOCATIONS AND DRAINAGE AREAS

Figure 2-1 is an overview of the study area with all mass emission monitoring sites shown. Table 2-1 also indicates the dominant land use associated with each monitoring site and the total drainage area.

Provided below is a description of the six mass emission stations, Ballona Creek, Malibu Creek, Los Angeles River, San Gabriel River, Coyote Creek, and Dominguez Channel, required by the Municipal Storm Water Permit for the 2001-2002 monitoring period. Figures 2-2 through 2-7 show the location of each monitoring station along with a description of its land use.

Ballona Creek Monitoring Station (S01)

The Ballona Creek monitoring station is located at the existing stream gage station (Stream Gage No. F38C-R) between Sawtelle Boulevard and Sepulveda Boulevard in the City of Los Angeles. At this location, which was chosen to avoid tidal influences, the upstream tributary watershed of Ballona Creek is 88.8 square miles. The entire Ballona Creek Watershed is 127.1 square miles. At the gauging station, Ballona Creek is a concrete lined trapezoidal channel.

Malibu Creek Monitoring Station (S02)

The Malibu Creek monitoring station is located at the existing stream gage station (Stream Gage No. F130-9-R) near Malibu Canyon Road, south of Piuma Road. At this location, the tributary watershed to Malibu Creek is 104.9 square miles. The entire Malibu Creek Watershed is 109.9 square miles.

Los Angeles River Monitoring Station (S10)

The Los Angeles River Monitoring Station is located at the existing stream gage station (Stream Gage No. F319-R) between Willow Street and Wardlow Road in the City of Long Beach. At this location, which was chosen to avoid tidal influences, the total upstream tributary drainage area for the Los Angeles River is 825 square miles. This river is the largest watershed outlet to the Pacific Ocean in Los Angeles County. At the site, the river is a concrete lined trapezoidal channel.

Coyote Creek Monitoring Station (S13)

The Coyote Creek Monitoring Station is located at the existing ACOE stream gage station (Stream Gage No. F354-R) below Spring Street in the lower San Gabriel River watershed. The site assists in determining mass loading for the San Gabriel River watershed. At this location, the upstream tributary area is 150 square miles (extending into Orange County). The sampling site was chosen to avoid backwater effects from the San Gabriel River. Coyote Creek, at the gauging station, is a concrete lined trapezoidal channel. The Coyote Creek sampling location has been an active stream gauging station since 1963.

San Gabriel River Monitoring Station (S14)

The San Gabriel River Monitoring Station is located at an historic stream gage station (Stream Gage No. F263C-R), below San Gabriel River Parkway in Pico Rivera. At this location the upstream tributary area is 450 square miles. The San Gabriel River, at the gauging station, is a grouted rock-concrete stabilizer along the western levee and a natural section on the eastern side. Flow measurement and water sampling are conducted in the grouted rock area along the western levee of the river. The length of the concrete stabilizer is nearly 70 feet. The San Gabriel River sampling location has been an active stream gauging station since 1968.

Dominguez Channel Monitoring Station (S28)

The Dominguez Channel Monitoring Station is located at Dominguez Channel and Artesia Boulevard in the City of Torrance. At this location, which was chosen to avoid tidal influence, the upstream tributary area is 33 square miles. The portion of the river where the monitoring site is located is a concrete-lined rectangular channel.

This section describes the field and laboratory methods used to implement the Monitoring Program, which includes precipitation and flow monitoring, storm water sampling, and laboratory analyses.

3.1 PRECIPITATION AND FLOW MEASUREMENT

3.1.1 Precipitation Monitoring

For every monitoring station, a minimum of one automatic tipping bucket (intensity measuring) rain gage is located nearby or within the tributary watershed. Large watersheds may require multiple rain gages to accurately characterize the rainfall. The LACDPW operates various automatic rain gages throughout the county. Existing gages near the monitored watersheds are also utilized in calculating storm water runoff and are essential to develop runoff characteristics for these watersheds.

3.1.2 Flow Monitoring

Flow monitoring equipment is needed to trigger the automated samplers because the Monitoring Program requires flow-weighted composites for many constituents. Flows are determined from measurements of water elevation as described below.

The water elevation in a storm drain is measured by the stage monitoring equipment, and the flow rate is derived from a previously established rating table for the site or calculated with an equation such as Manning's. The LACDPW uses rating tables generated from analysis of storm drain cross sections and upstream/downstream flow characteristics. The rating tables are modified if it is demonstrated in the field through stream velocity measurements that calculated table values are incorrect. Previous storm water flow measurement efforts indicates that all stations will require multiple storm events to gather the data necessary for calibration of the measurement devices.

The automatic samplers utilize pressure transducers as the stage measurement device. However, pressure transducers are only accurate as flow measurement devices in open channel flow regimes. Therefore, for stations monitoring flows in underground storm drains, efforts were made to select drains that do not surcharge (flow under pressure) during events smaller than a 10-year storm event.

3.2 STORM WATER SAMPLING

3.2.1 Sample Collection Methods

Grab and composite sample collection methods, defined below, were used during the 2001-2002 storm season.

- **Grab Sample** - a discrete, individual sample taken within a short period of time, usually less than 15 minutes. This method is used to collect samples for constituents that have very short holding times and specific collection or preservation needs. For example, samples for coliforms are taken directly into a sterile container to avoid non-resident bacterial contamination.

- **Composite Sample** - a mixed or combined sample created by combining a series of discrete samples (aliquots) of specific volume, collected at specific flow-volume intervals. Composite sampling is ideally conducted over the duration of the storm event.

During a storm event, grab samples were collected during the initial portion of the storm (on the rising limb of the hydrograph) and taken directly to the laboratory.

Flow composite storm samples were obtained using an automated sampler to collect samples at flow-paced intervals. Samples collected at each station were combined in the laboratory to create a single flow-weighted sample for analysis.

During the storm season, the sampler was programmed to start automatically when the water level in the channel or storm drain exceeded the maximum annual dry weather stage. A sample was collected each time a set volume of water had passed the monitoring point (this volume is referred to as the pacing volume or trigger volume). The sample was stored in glass containers within the refrigerated sampler. A minimum of eight liters of sample was required to conduct the necessary laboratory analyses for all the constituents. The automated sampler was deactivated by field personnel when the water level in the channel or storm drain fell to about 120 percent of the observed maximum annual dry weather flow stage.

Samples were retrieved from the automated samplers as soon as possible to meet laboratory analysis holding time requirements. As samples were collected, rainfall and runoff data were logged and stored for transfer to the office.

3.2.2 Field Quality Assurance/Quality Control Plan

Properly performed monitoring station set up, water sample collection, sample transport, and laboratory analyses are vital to the collection of accurate data. Quality Assurance/Quality Control (QA/QC) is an essential component of the monitoring program.

Evaluation of Analytes and QA/QC Specifications for Monitoring Program (Woodward-Clyde, 1996a) describes the procedures used for bottle labeling, chain-of-custody tracking, sampler equipment checkout and setup, sample collection, field blanks to assess field contamination, field duplicate samples, and transportation to the laboratory.

An important part of the QA/QC Plan is the continued education of all field personnel. Field personnel were adequately trained from the onset and informed about new information on storm water sampling techniques on a continuing basis. Field personnel also evaluate the field activities required by the QA/QC Plan, and the Plan is updated if necessary.

Bottle Preparation

For each monitoring station, a minimum of three sets of bottles was available so that up to two complete bottle change-outs could be made for each storm event. Bottle labels contained the following information:

- LACDPW Sample ID Number
- Station Number
- Station Name

- Sample Type (Grab or Composite)
- Laboratory Analysis Requested
- Date
- Time
- Preservative
- Temperature
- Sampler's Name

Bottles were cleaned at the laboratory prior to use, then they were labeled and stored in sets. Each station was provided with the same number, types, and volumes of bottles for each rotation unless special grab samples were required. Clean composite sample bottles were placed in the automated sampler when samples were collected. This practice ensured readiness for the next storm event. All bottles currently not in use were stored and later transported in plastic ice chests. Composite sample bottles were limited to a maximum of 2-1/2 gallons each, to ensure ease of handling.

Chain-of-Custody Procedure

Chain-of-custody forms were completed to ensure and document sample integrity. These procedures establish a written record which tracks sample possession from collection through analysis.

Field Setup Procedures

All field sampling locations were fixed sites, with the sampler placed on a public road or flood control right-of-way. After sample collection, field staff prepared the sampler for collection of the next set of samples either in storm mode or in dry weather mode. Inspection of visible hoses and cables was performed to ensure proper working conditions according to the site design. Inspection of the strainer, pressure transducer, and auxiliary pump was performed during daylight hours in non-storm conditions.

The automated sampler was checked at the beginning of the storm (during grab sample collection) to ensure proper working condition and to see if flow composite samples were being collected properly. Dry weather collection techniques were similar, with grab and 24-hour composite samples being collected.

Bottles were collected after each event and packed with ice and foam insulation inside individually marked ice chests. Chain-of-custody forms were completed by field staff before transportation of the samples to the laboratory. Under no circumstance were samples removed from the ice chest during transportation from the field to the laboratory.

Travel Blanks and Field Duplicates

Potential field contamination was assessed through analysis of travel blanks and duplicate grab samples. Field travel blanks were collected for each monitoring station during every sampling event to quantify post sampling contamination. The monitoring program also included field duplicates to assess the precision of laboratory results. A field duplicate, the origin of which was unknown to the laboratory, was collected for each sampling event. This methodology for assessing post sampling contamination and laboratory testing procedures provided data to measure the precision and accuracy of the laboratory results.

3.3 LABORATORY ANALYSES

The Department of Agricultural Commissioner/Weights and Measures (ACWM) Environmental Toxicology Laboratory provides water quality laboratory and related services to the LACDPW. The ACWM lab is state certified to perform the water quality analyses contracted by LACDPW. The ACWM Lab maintains a laboratory analysis program that includes Quality Assurance and Quality Control protocols consistent with the objectives of the monitoring program required by the Permit.

3.3.1 Chemical and Biological Analysis

The suite of analytes and associated minimum levels (MLs) for samples collected at mass emission stations are specified in the Municipal Storm Water Permit. All the laboratory methods used for analysis of the storm water samples are approved by the California Department of Health Services and are in conformance with U.S. Environmental Protection Agency (USEPA) approved methods.

Table 3-1 shows all the constituents monitored during the 2001-2002 reporting period, including constituents analyzed with composite or grab samples. The table lists the method number, the ML, the method detection limit (MDL), and other relevant information for each constituent.

The Municipal Storm Water Permit defines MDL and ML as follows:
MDL means the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. ML means the concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed. Throughout this report, “0” for sample results indicates the analyte concentration is less than the ML.

The primary objective of the laboratory QA/QC program is to ensure that the analyses are scientifically valid, defensible, and of known precision and accuracy. The ACWM laboratory maintains QA/QC procedures (as described in their Quality Assurance Manual) in accordance with requirements of the California Department of Health Services. The ACWM laboratory standard operation procedures include method validation, equipment calibration, preventive maintenance, data validation procedures, assessment of accuracy and precision, corrective actions, and performance and system audits. ACWM Lab conducted the QA/QC review and data validation for the 2001-2002 monitoring data, and the QA/QC documentation is available within the ACWM Lab files. The validated data as provided by the ACWM Lab were used for data analysis and interpretation with no further QA/QC review.

3.3.2 Toxicity Analysis

The samples were subjected to the Ceriodaphnia dubia 7-day survival and reproduction tests in addition to the Strongylocentrotus purpuratus (sea urchin) fertilization test as a measure of toxicity. Performed as multi-concentration tests, sample concentrations of 100%, 56%, 32%, 18%, 10% and 0% (N-control) were used to determine the level of toxicity. These tests were conducted under guidelines prescribed in *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms* (US EPA, 1995).

Water quality measurements (temperature, pH, dissolved oxygen, hardness, conductivity, and alkalinity) were made for each sample at the beginning and throughout each test. These measurements were performed to ensure there were no large variations in water quality, which can affect the accuracy of the toxicity tests.

This section describes the results, data analysis, and recommendations for the 2001-2002 Monitoring Program.

4.1 HYDROLOGY: PRECIPITATION AND FLOW

The monthly rainfall during the 2001-2002 storm season was compared to the long-term pattern of rainfall in Figure 4-1. During this storm season, the total rainfall was about 4.16 inches and about 79% of the total rainfall fell during the months of November through January. Figure 4-2 shows that the total annual rainfall of 4.16 inches during the 2001-2002 storm season in Los Angeles County was significantly below the average rainfall. The average annual rainfall over 130 years at Station # 716, Ducommun Street in downtown Los Angeles is about 15.51 inches.

Table 4-1 summarizes the hydrologic and meteorologic conditions of each station-event monitored during this storm season. A collection of 2001-2002 season hydrographs for each storm event from the monitored sites is included in Appendix A. Each hydrograph includes the time of the first and last composite sample aliquot collection, the number of aliquots per composite, the sample volume interval, and the percent of storm sampled.

4.2 STORM WATER QUALITY

An inventory of the composite and grab samples taken for the chemical and biological analysis and toxicity analysis during the 2001-2002 monitoring season is included in Tables 4-2 and 4-3.

4.2.1 Mass Emission Analysis

This section provides a description of wet-weather results generated during the 2001-2002 monitoring season.

The County analyzes for an extensive number of individual water quality constituents, the results of which are included in Appendix B. A comparison was made between mass emission water quality results and the water quality objectives outlined in the Ocean Plan, the Basin Plan, and the CTR. The objectives in the AB411 were also used to provide water quality standards for bacteria. The Municipal Storm Water Permit specifically requires the County to assess the pollutant loading for the sampling events that are analyzed for the complete list of constituents following the 2001-2002 storm season. In addition, the Municipal Storm Water Permit requires the identification and analysis of any long-term trends in storm water or receiving water runoff. An analysis of the correlation between pollutants of concern (metals and PAHs) and TSS loadings for the sampling events was also performed.

4.2.1.1 Comparison Study

As required by the Municipal Storm Water Permit, a comparison to the applicable water quality standards from the Basin Plan, the Ocean Plan, or the CTR for the mass emission monitoring was conducted. The objectives in the AB411 were used to provide standards for bacteria. The lowest possible standard of the four documents was used for the comparison study. Constituents that exceeded the applicable water quality standards are highlighted in Appendix B. Table 4-4 and Figure 4-3 summarize this comparison analysis.

The following conclusions were drawn from the comparison study:

- The monitoring program has identified the nearly ubiquitous existence of bacteria in wet weather for all six of the mass emission monitoring stations. Densities of total coliform, fecal coliform, and enterococcus exceeded the public health criteria of AB411 for each storm at each monitoring station, with the exception of Malibu Creek, which only exceeded the total and fecal coliform objectives half of the time. The Malibu Creek station also shows consistently lower indicator bacteria counts than other mass emission stations.
- For all monitoring stations, there was no clear trend between bacteria densities and storm events.
- For all monitoring stations, over 66% of the ammonia samples exceeded the Basin Plan water quality objectives.
- For all monitoring stations, 50-100% of the total copper samples exceeded the Ocean Plan water quality objective.
- At least 40% of the dissolved copper samples taken at the Ballona Creek, Los Angeles River, Coyote Creek, and Dominguez Channel monitoring stations exceeded the CTR water quality objective.
- 50% of the dissolved selenium samples collected at the Malibu Creek monitoring station exceeded the CTR water quality objective. This is the only monitoring station that showed exceedances.
- 40% of the dissolved lead samples collected at the Los Angeles River monitoring station and 17% of the samples collected at the San Gabriel River monitoring station exceeded the CTR water quality objective. No other monitoring stations showed exceedances.

4.2.1.2 Loading and Trend Analysis

An estimation of the total pollutant loads due to storm water and urban runoff for each mass emission station was made in Table 4-5. By analyzing the pollutant loading at each mass emission station, it is possible to see if there is any correlation between storm events and the amount of pollutant loading. An analysis of trends in storm water or receiving water quality was also conducted in Figure 4-4. Though it is difficult to see any trends at this time, they will become more apparent in years to come as sampling continues.

The following conclusions were deduced from the loading analysis:

- The storm on November 24, 2001 at the Ballona Creek and Los Angeles River monitoring stations produced loadings of 2,001 tons and 12,145 tons, respectively. The storm on this date produced the highest amount of precipitation at both of these stations during the 2001-2002 monitoring season. Besides these two occurrences, the mass emission loadings for TSSs were less than 1,300 tons for all monitoring stations for all storms.
- The Los Angeles River is the largest contributor of TSSs out of the six mass emission stations monitored.
- Loading was highest for most constituents at each monitoring station during the November 24, 2001 storm.
- Metal loading was the greatest for the Los Angeles River.

The following conclusions were drawn from the trend analysis:

- The high levels of zinc found at monitoring stations between 1994-2000 were not present in the samples taken during the 2001-2002 storm season.
- The rainfall was approximately 11.3 inches below average during the 2001-2002 storm season.

4.1.2.3 Correlation Study

An analysis of the correlation between metals/PAHs and TSS levels for the mass emission monitoring was performed. Dominguez Channel was not used in the correlation study since there was only one sampling event. The study focused on metals because there were not enough PAH samples to find any correlation.

A trend line was placed on each of the metals-versus-TSS plots and the coefficient of determination (R^2) was measured to see if there was any correlation between each metal and TSSs for the mass emission monitoring stations (Figure 4-5). The closer R^2 is to the value one, the stronger the correlation. A consistent trend of correlations for a metal at each of the mass emission sites was analyzed.

The following conclusions were deduced from the correlation study analysis:

- All of the five mass emission monitoring sites showed a positive correlation between total manganese and TSSs. Each site had an R^2 value greater than 0.865, except for San Gabriel River, which had an R^2 value of 0.586.
- Ballona Creek, Malibu Creek, Los Angeles River, and Coyote Creek showed a strong positive correlation between total aluminum and TSSs, having R^2 values of 0.9271, 0.9326, 0.7953, and 0.7699, respectively.
- Three of the mass emission sites, Ballona Creek, Coyote Creek, and San Gabriel River, showed a slightly positive correlation between dissolved nickel and TSSs, with R^2 values ranging from 0.615 to 0.67.

4.2.2 Water Column Toxicity Analysis

This section describes the water column toxicity results generated during the 2001-2002 storm season. Due to a lack of storm events and insufficient runoff to collect the required sample volume for analysis during the 2001-2002 storm season, it was not possible to collect samples from two storm events or at every monitoring station.

A minimum of one freshwater and one marine species was used for toxicity testing, specifically Ceriodaphnia dubia (water flea) 7-day survival/reproduction and Strongylocentrotus purpuratus (sea urchin) fertilization.

Results calculated from the Ceriodaphnia dubia and sea urchin tests included the no observed effect concentration (NOEC), 50% lethal concentration (LC50), 50% inhibitory concentration (IC50), and toxicity unit (TU), as shown in Table 4-6. NOEC is the highest concentration causing no effect on the test organisms. LC50 is the concentration that produces a 50% reduction in survival. IC50 is the concentration causing 50% inhibition in growth or reproduction. TU is defined in the permit as 100/(LC50 or IC50). A TU value greater than or equal to one is considered substantially toxic and requires a toxicity identification evaluation (TIE).

The following conclusions were deduced from water column toxicity testing:

- Ceriodaphnia dubia survival was not significantly affected by exposure to any of the samples. Each undiluted sample caused less than a 50% reduction in survival. This resulted in each sample being less than one toxic unit, meaning none of the samples were substantially toxic.
- The samples tested for Ceriodaphnia dubia reproduction from the Los Angeles River had an LC50 value equal to 92.36%. This means the Los Angeles River sample caused a 50% decrease in reproduction when it was diluted to 92.36% of its original strength. This represents a TU of 1.08. A TIE was not completed because there was not sufficient runoff to collect the required sample volume for such an analysis. The samples taken from the other three stations had TU values less than one.
- In the sea urchin fertilization tests, the Los Angeles River, San Gabriel River, and Dominguez Channel had IC50 values of 52.20%, 55.30%, and 52.63% which equates to TU values of 1.92, 1.81, and 1.90, respectively. Again, a TIE was not completed because there was not sufficient runoff to collect the required sample volume for such an analysis. The sample from Coyote Creek was not substantially toxic to sea urchin fertilization.

4.2.3 Identification of Possible Sources

This section describes the possible sources of the constituents that do not meet the water quality objectives in all or most of the watersheds, as discussed above in Section 4.2.1.

The source of bacteria is hard to pinpoint. According to the *Draft Total Maximum Daily Load to Reduce Bacterial Indicator Densities at Santa Monica Bay Beaches* published on November 8, 2001 by the California Regional Water Quality Control Board, Los Angeles Region, urban runoff from the storm drain system may have elevated levels of bacterial indicators due to sanitary sewer leaks and spills, illicit connections of sanitary lines to the storm drain system, runoff from homeless encampments, illegal discharges from recreational vehicle holding tanks, and malfunctioning septic tanks among other things. Fecal matter from animals and birds can also elevate bacteria levels.

Common point and nonpoint sources of ammonia and other nutrients include urban runoff, livestock operations, and the atmosphere (wet deposition) as stated in the *Protocol for Developing Nutrient TMDLs*, published by the EPA in November 1999.

According to G. Fred Lee, PhD and Anne Jones-Lee, PhD, copper can come from brake pads or industrial (such as the textile industry) and mining sources.

4.2.4 Recommendations

As stated previously, there was not a sufficient number of storm events and, for some of the storm events, there was not enough runoff for collecting the sample volume needed for further analysis during the 2001-2002 storm season; therefore, it was not possible to complete the number of sampling events required for mass emission monitoring at Dominguez Channel and for toxicity monitoring. Make-up samples will be collected during the following storm season and the results will be included in the 2002-2003 monitoring report. Dry weather sampling for both mass emission and toxicity monitoring will be conducted in the near future and the results will also be included in the 2002-2003 monitoring report.

In order to identify and better understand the source(s) of pollution, mass emission monitoring and toxicity monitoring will be continued and additional monitoring, such as tributary monitoring, will be performed in the future as required by the Municipal Storm Water Permit. The effectiveness of the existing control measures used to control pollution will be evaluated by the BMP effectiveness study.

California Code of Regulations. Title 17, section 7958, Bacteriological Standards.

California Regional Water Quality Control Board, Los Angeles Region. 1990. Waste Discharge Requirements for Municipal Storm Water and Urban Runoff Discharges Within the County of Los Angeles. Order No. 90-079, NPDES Permit No. CAS0061654.

California Regional Water Quality Control Board, Los Angeles Region. 1995. Water Quality Control Plan, Los Angeles Region, Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties.

California Regional Water Quality Control Board, Los Angeles Region. 1996. Waste Discharge Requirements for Municipal Storm Water and Urban Runoff Discharges Within the County of Los Angeles. Order No. 96-054, NPDES Permit No. CAS614001.

California Regional Water Quality Control Board, Los Angeles Region. 2001. Draft Total Maximum daily Load to Reduce Bacterial Indicator Densities at Santa Monica Bay Beaches.

California Regional Water Quality Control Board, Los Angeles Region. 2001. Waste Discharge Requirements for Municipal Storm Water and Urban Runoff Discharges Within the County of Los Angeles, and the Incorporated Cities Therein, Except the City of Long Beach. Order No. 01-182, NPDES Permit No. CAS004001.

Chapman, G.A., D.L. Denton, and J.M. Lazorchak. 1995. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms. EPA/600/R-95/136, National Exposure Research Laboratory, U. S. Environmental Protection Agency, Cincinnati, OH. 661p.

G. Fred Lee, PhD, PE, DEE and Anne Jones-Lee, PhD. Regulating Copper in Urban Stormwater Runoff. G. Fred Lee & Associates, El Macero, California.

State Water Resources Control Board. 2001. California Ocean Plan, Water Quality Control Plan for Ocean Waters of California.

U.S. Environmental Protection Agency. 1999. Protocol for Developing Nutrient TMDLs. EPA 841-B-99-007. Office of Water (4503F), United States Environmental Protection Agency, Washington D.C. 135 pp.

U.S. Environmental Protection Agency. 2000. The California Toxics Rule (CTR): Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California. 40 CFR Part 131.

Woodward Clyde Consultants. 1996a. Evaluation of Analytes and QA/QC Specifications for Monitoring Program. Report prepared for Los Angeles County Department of Public Works, Alhambra, CA, December 1996.